AN
ACCOUNT OF A METHOD
OF
PRESERVING WATER,
AT SEA, &c.

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1807

AN ACCOUNT OF A METHOD OF PRESERVING WATER, AT SEA,

FROM

PUTREFACTION,

AND OF

RESTORING TO THE WATER

ITS ORIGINAL PLEASANTNESS AND PURITY,

BY A CHEAP AND EASY PROCESS:

TO WHICH IS ADDED

A MODE OF IMPREGNATING WATER,

IN LARGE QUANTITIES,

WITH FIXED AIR,

For MEDICINAL USES, on BOARD SHIPS, and in HOSPITALS;

AND LIKEWISE

A PROCESS FOR THE PREPARATION OF

ARTIFICIAL YEAST.

Dc

By THOMAS HENRY, F. R. S.
And MEMBER of the MEDICAL SOCIETY of LONDON.

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MDCCLXXXI.

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Jos: Banks

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TO THE RIGHT HONOURABLE

JOHN

EARL OF SANDWICH, &c.

FIRST LORD COMMISSIONER,

AND TO THE OTHER

LORDS COMMISSIONERS

FOR EXECUTING THE OFFICE OF

LORD HIGH ADMIRAL OF GREAT BRITAIN,

THE FOLLOWING ACCOUNT OF A

METHOD OF PRESERVING WATER, AT SEA,
FROM PUTREFACTION, &c.

IS,

WITH THEIR LORDSHIPS' PERMISSION,

MOST RESPECTFULLY INSCRIBED

BY THEIR DEVOTED AND OBEDIENT

HUMBLE SERVANT,

MANCHESTER,
May 24, 1781.

THOMAS HENRY.

PREFACE.

THE Author of the following Account is by no means ignorant of the advantages which may be derived from the mode of diſtilling Sea-Water, which has been lately invented; but he apprehends it is intended only to furniſh a partial ſupply of freſh water, in caſes of neceſſity, and inſufficient for the conſumption of a large crew: whereas his ſcheme aims at the conſtant preſervation of water, from the putrefaction to which it is expoſed in long voyages. The ſame proceſs, alſo, which is directed for the precipitation of the lime, may, with a ſmaller portion of the effervesſcing ſubſtances, be commodiouſly uſed for the ſpeedy reſtoration of the air of which water is deprived by diſtillation; and thus the objections which have been made to the want of ſpirit and ſuppoſed inſalubrity of diſtilled water will be effectually removed, whenever the conſumption of a ſhip's ſtore of water ſhall render it neceſſary to have recourſe to diſtillation.

ERRATUM.

Page 26, line 19, *for* remained *read* remains.

AN ACCOUNT OF A METHOD OF PRESERVING WATER ON SHIP-BOARD FROM PUTREFACTION, &c.

THAT the ſtrength, ſafety and wealth of this nation depend principally on her Marine, is a fact, the truth of which has been long eſtabliſhed. The preſervation, therefore, of the health and lives of our Seamen ſhould always have been conſidered as a primary object of attention, by Government.

Yet notwithſtanding the ravages made by that deſtructive diſeaſe, the ſea-ſcurvy, among this valuable body of men, ſo little had been done towards the prevention of the evil, that even at ſo late a period as that of the late Lord Anſon's circumnavigation, the Centurion, the Commodore's ſhip, before ſhe had reached the iſland of Juan Fernandes, had buried two hundred of her crew, and could muſter no greater a number than ſix of the common ſailors in a watch, who were capable of doing duty. The other two ſhips which arrived at that iſland, had ſuffered in proportion.

The remaining part of the crews of the three ſhips, having, by means of freſh air and vegetable diet, during their continuance on the iſland, recovered from the ſcurvy, embarked on board the Centurion; but before the ſhip arrived at Tinian the ſickneſs returned, and, at the expiration of the ſecond year, ſo great had been the mortality, that, horrid to relate! the hiſtorian of the voyage informs us, more than four fifths of the original number of theſe brave, theſe uſeful members of ſociety had fallen victims to the ſcurvy or putrid fevers.

How great the contraſt between this melancholy deſcription, and the pleaſing narrative which the ever to be lamented captain Cook has given of a voyage equally long in its duration, and more variable in climate. In this voyage, in which he paſſed through all the climates from 52 deg. N. to 71 S. with a company of one hundred and eighteen men, and the performance of which employed no leſs a period than three years and eighteen days, this prudent, this humane Commander loſt only one man by diſeaſe; and it even appears that this man carried on board with him the primary ſymptoms of the diſorder which, afterwards, deſtroyed him.

Much praiſe is due to Government for the many ſalutary arrangements made on board the veſſels ſent on that expedition, previous to their ſailing; and great was the merit of the excellent Commander of the Reſolution, in the unremitting attention paid by him to the uſe of every thing that could contribute, and the avoiding of every thing injurious, to the health and preſervation of his men. Juſtly did the Royal Society decree to him the honourable reward of their annual medal, and moſt juſtly are his merits celebrated in the eloquent oration, delivered on that occaſion, by the late learned and worthy preſident, Sir John Pringle.

In the voyage which captain Cook performed, with ſuch extraordinary ſucceſs, he was particularly fortunate in meeting with frequent ſupplies of freſh water.* The iſlands in the South Sea, at which he ſtopped, abounded with ſprings of excellent water; and when, in the high ſouthern latitudes, after a long abſence from land, he was in danger of a ſcarcity of that article, the mountains of ice unexpectedly furniſhed him with an ample quantity of it; the ſalt having been precipitated from the ſea water by the act of freezing—a circumſtance which though it had been, in general, either unattended to, or controverted, has been amply confirmed by experiment.*

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* "I never failed to take in water wherever it was to be procured, even when we did not ſeem to want it; becauſe I look upon freſh water from the ſhore to be much more wholeſome than that which has been kept ſome time on board."

Captain Cook's Method for preſerving the Health of Seamen.
Phil. Tranſ. vol. LXVI. p. 405.

If this had not been the caſe, and had the crew of the Reſolution been under the neceſſity of drinking water in that putrid ſtate to which it is too frequently reduced in long voyages, it is to be feared that all the other precautions would have fallen ſhort of the ſucceſs that attended them. The ſea-ſcurvy is allowed on all hands, to be a putrid diſeaſe, and to be the conſequence of putrid air, putrid proviſions, putrid water, and the deficiences of vegetable diet and cleanlineſs.

The drinking of putrid water is not only highly diſagreeable and diſguſting, but extremely noxious to the conſtitution. Every kind of putrid matter received into the body acts as a ferment, and ſpreads its influence through the animal ſyſtem. Were the former the only inconvenience experienced by the gallant defenders of our iſland, the gratitude we owe them, ſhould make us anxious to remove it: but when we ſee theſe brave men languiſhing from the want of freſh and wholeſome water;* when we ſee diſeaſes undermining thoſe conſtitutions which nature had formed to laſt to a good old age; when we behold thoſe lives, ſo valuable to their country, prematurely deſtroyed by the ſame deleterious cauſe, what zeal can be too ardent, what endeavours too active to remove the evil!

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* Mr Nairne's Experiments on Water obtained from the melted ice of ſea water.

Phil. Tranſ. vol. LXVI. p. 249.

A method of preſerving water free from putrefaction was ſome years ſince propoſed by the late Dr. Alſton. It conſiſted in adding a quantity of lime to every caſk of water. That ſubſtance is known to have a ſtrong antiſeptic property; and water, as long as it retains the impregnation of lime, never putrifies. But the lime communicates a diſagreeable taſte to the water, and, abſtracted from that inconvenience, might, perhaps, in many inſtances, be detrimental.

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* "I am convinced, that with plenty of freſh water, and a cloſe attention to cleanlineſs, a ſhip's company will ſeldom be much afflicted with the ſcurvy, though they ſhould not be provided with any of the antiſcorbutics before-mentioned."

Phil. Tranſ. vol. LXVI. p. 403.

To free the water, at the time of uſing it, from the lime, Dr. Alſton propoſed the precipitation of the latter, by throwing into the water a quantity of magneſia alba; on this principle; that as lime-ſtone is rendered ſoluble in water by its deprivation of fixed air, and has a greater affinity with that air than magneſia has, the particles of quick-lime diſſolved in the water would attract the air from the magneſia, and thereby becoming no longer ſoluble, would fall to the bottom, and leave the water taſteleſs and fit for œconomical uſes.

Dr. Alſton's theory was juſt; but the expence attending it, owing to the price of magneſia was ſuch (though the expence ſhould be great indeed which is to be placed in the balance againſt the preſervation of our mariners) as to prevent the execution of the propoſal.

My attention was directed ſome time ſince to this ſubject, by the trouble I had often experienced from the water in the tub, intended to cool the worm of my ſtill, becoming putrid, if not frequently emptied; and the labour of filling it with freſh water was irkſome to my ſervant from the diſtance he had to carry it. The putrefaction of it was accelerated by the neceſſity of the tub being placed within a very ſmall diſtance of a continual fire which is kept in my laboratory, and the fetor of the putrid water was exceedingly offenſive. It occurred to me that the addition of lime to the freſh water might obviate the inconvenience. The event has far exceeded my moſt ſanguine expectations; for the water, though very repeatedly expoſed to the heat raiſed in diſtillation, added to the warm ſituation in which it was placed, continued free from the leaſt degree of putrefaction above eighteen months, and was then thrown away, only becauſe it was become foul from duſt. The water, waſted by evaporation, was ſupplied from time to time by freſh quantities, but the original water was never removed during that period,* and it was conſtantly expoſed to the action of the atmoſpherical air.

So ſtrong a proof of the antiſeptic influence of lime on water impreſſed me forcibly. Dr. Alſton's ſcheme recurred to my mind, and it appeared very deſirable to invent ſome method of rendering it more applicable to the purpoſes of the navy. This would be accompliſhed, if a cheap and eaſily practicable method could be diſcovered of precipitating the lime, and thereby reſtoring the water to its original taſte.

In order to produce this effect, I have made a variety of experiments, with the relation of which I ſhall not detain the reader; but ſhall proceed to deſcribe the method of impregnating the water with lime, and alſo the means of precipitating the lime from the water, at the time of its uſe, and reſtoring its original ſweetneſs and pleaſantneſs; after which I ſhall give an account of an eaſy method of impregnating water, *in large quantities*, with fixed air, for the uſe of the ſick on board his Majeſty's and other ſhips, as well as for hoſpital practice.

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* This method would prevent much labour in large diſtilleries.

The Method of impregnating the Water with Quick-Lime.

To every caſk of water of 120 gallons, add * two pounds of well burnt quick-lime, either freſh from the kiln, or preſerved, as directed in a ſubſequent part of this Treatiſe. When the lime has been in the caſk ſome minutes, and the heat and efferveſcence occaſioned by the mixture are over, let the caſk be carefully ſtopped from any communication with the external air.

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* In the directions lately publiſhed, by order of the French government, for preſerving the health of their Seamen, which are inſerted in the third number of the Medical Commentaries for 1780, they have adopted the practice of adding quick-lime, in the proportion of one pound to every whole caſk, and half a pound to each half caſk of water. Had they been acquainted with a method of again freeing the water from the lime, they would, doubtleſs, have preſcribed a larger proportion of the latter; for they acknowledge that quantity to be inſufficient to preſerve the water free from putrefaction: to correct which, they direct a quantity of vinegar to be added at the time the water is drawn off for uſe.

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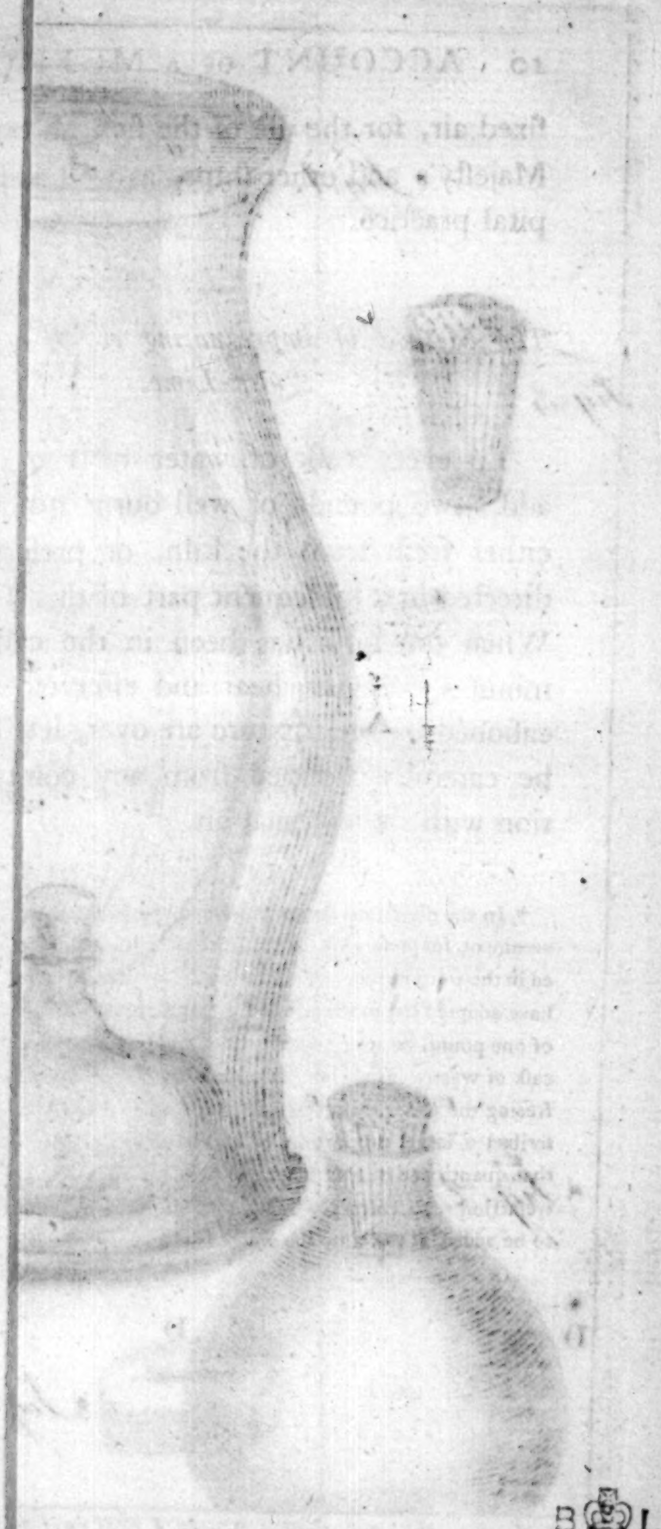

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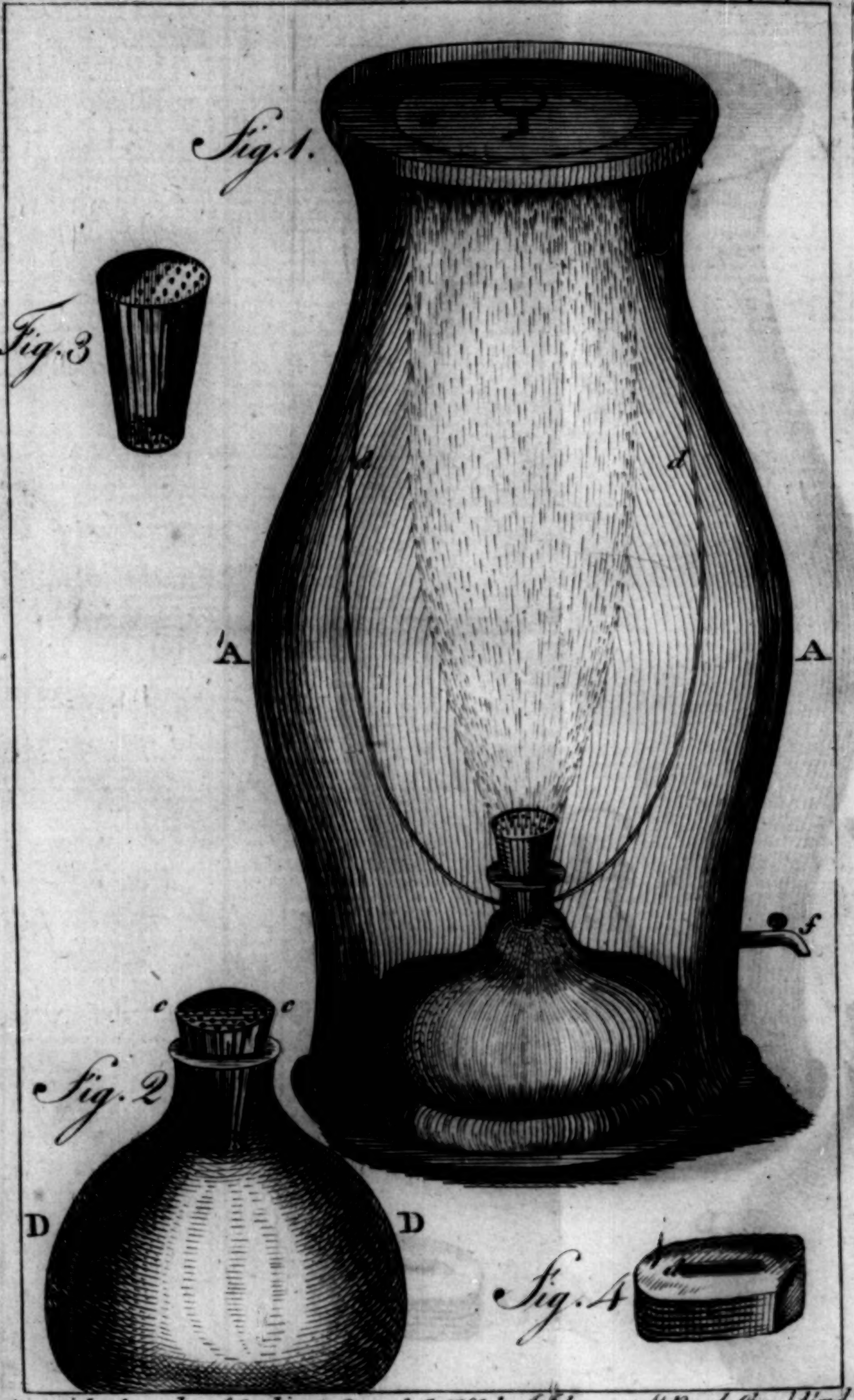

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[illegible] passing the [illegible] Preserving Lime, [illegible] using it as [illegible].

[illegible] (A, Fig. 1) be prepared, of a [illegible] however in its diameter, in [illegible] depth than usual. The top [illegible] formed of one piece, and have [illegible] of the centre of a circular [illegible] as can be allowed without [illegible] the sides too much. [illegible] should be made to fit [illegible] as [illegible] and have an iron handle [illegible] affixed [illegible] the purpose of [illegible] of [illegible] (fig. [illegible]) [illegible] to a [illegible] small hole (c) [illegible] which [illegible] for a [illegible]

[illegible] they [illegible]

Fig

The Method of freeing the Water from the Lime, and reſtoring it to its former State.

Let a caſk, (AA, fig. 1.) be prepared, of a form ſomething narrower in its diameter in proportion to its depth than uſual. The top, *(a)* muſt be formed of one plank, and have a piece cut out of the centre, of a circular form, and as large as can be allowed without weakening the ſides too much.* This piece, or bung, muſt be made to fit as cloſely as poſſible, and have an iron handle *(b)* affixed to it, for the purpoſe of lifting it, and of confining a weight (fig. 4.) which is to be laid on, to keep the bung from yielding to a ſmall force from within. A ſmall hole *(c)* muſt be bored in the ſide of the top, which is to be exactly ſtopped with a plug, for a purpoſe to be explained in the ſequel.

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* If theſe ſides be made of ſtrong timber, cloſely cemented, they may be ſufficiently firm; and the bung may be formed of a thicker plank, and turned in a lathe ſo as to fit very cloſely.

Fill this caſk, which may be ſuppoſed to contain ſixty gallons, ſecured on a convenient part of the deck, or ſlung up in the ſhrouds, with the lime-water, drawn off clear from the ſediment, ſo as to avoid any viſible particles of lime floating in it; allowing ſufficient room for the air veſſel, and a free ſpace of about half an inch between the ſurface of the water and the top of the caſk.

Let a veſſel (DD, fig. 2.) be alſo prepared, capable of containing two gallons, or $\frac{1}{30}$ of the capacity of the caſk (AA, fig. 1.) Into this veſſel introduce half a pound of marble, pure *unburnt* lime-ſtone or chalk* groſsly powdered, and two quarts of water. Then pour gradually on theſe, three ounces of ſtrong vitriolic acid, commonly called oil of vitriol, and ſtopping the mouth of the veſſel (DD) with the tubulated ſtopper *(cc)* let it down by means of the ſtrings *(dd)* into the caſk† which is drawn tranſparent, to ſhew the ſtate of the whole apparatus. The fixed air, let looſe from the mild calcareous earth, will bubble up through the lime-water. When this has continued about a minute, the bung *(a)* is to be faſtened on, and the weight (C, fig. 4.) ſlipped over the ring of the handle *(b)* to keep the bung in its place. In about an hour the bung may be removed, in order to ſee whether the diſcharge of air continues. If it have ceaſed, or be conſiderably abated, three ounces more of vitriolic acid is to be added, and the air veſſel returned to its former ſtation in the caſk.

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* I ſhall, in future, make uſe of the term *mild calcareous earth* as including all theſe ſpecies of it; and of theſe the preference is to be given in the order in which they are placed in the text.

† Theſe ſtrings are to be faſtened to the pegs *(ee)* when the air veſſel is let down.

The time neceſſary to precipitate the lime from the water will be in proportion to the briſkneſs of the effervescence, but in general a few hours will be ſufficient. Should the firſt parcel of calcareous earth and vitriolic acid be unequal to the ſweetening of the lime-water, and no longer diſcharge air briſkly when agitated; the contents of the air veſſel are to be poured out, and a freſh quantity of the ingredients ſubſtituted in their place.

When the water is become quite mild, the air veſſel is to be taken out, and, if the calcareous earth continue to diſcharge air, be plunged into another caſk of lime-water, that there may be no needleſs expence of the fixed air.

The ſpecific gravity of the lime is ſo much ſuperior to that of the water, that it will ſoon fall to the bottom of the caſk when the operation is finiſhed. As ſoon as the water is become clear, it muſt be drawn off by the cock *(f)* for uſe; or, if the caſk be wanted to purify other quantities of water, it may be drawn off ſooner into other veſſels to clarify.

The precipitated lime may be collected and dried, and, being now in the ſtate of chalk, and impalpably powdered, may be uſed inſtead of prepared chalk for the medicinal purpoſes to which that article is applied.

Cautions to be obſerved in the above Proceſſes.

1. The quick-lime ſhould be choſen as pure, free from any foreign taſte, white, well

burnt and freſh from the kiln as can be obtained. What is carried to ſea for future uſe, ſhould be carefully packed up in clean tight caſks, ſo as to preſerve it from moiſture and the action of the air.

2. The caſks, into which the lime-water is put, ſhould be perfectly clean and ſweet; and thoſe ſhould be ſelected for this uſe that are well ſeaſoned and free from ſap.

3. The water is to be firſt poured into the air veſſel (DD;) then the calcareous earth, which is to paſs through a paper cone to prevent its adhering to the ſides of the mouth of the veſſel; and laſtly, the acid is to be added, no attention being paid to the mixing the earth and water intimately. By this means the acid attacks the calcareous earth gradually, and the veſſel is in no danger of burſting by the too ſudden exploſion of the air. For the ſame reaſon, care ſhould alſo be taken that the air veſſel be not ſhaken too rapidly.

4. Gently agitating the upper part of the caſk from time to time, during the proceſs, will accelerate the completion of it, by occaſioning a quicker abſorption of the fixed air. And the ſmall plug muſt occaſionally be taken from the orifice (*c*) to let out the part of the air which is not ſoluble in water.

5. The precipitated lime is to be cleared out of the caſk (AA) after each time of uſing it; and the caſk ſhould be frequently waſhed out thoroughly.

6. Care muſt be taken that the mouth of the air veſſel be clear of calcareous earth before the ſtopper be put in; and that the ends of the tubes in the ſtopper be not clogged up with any thing that may prevent the paſſage of the air through them.

7. Each ſhip ſhould be provided with ſeveral of the air veſſels, and each veſſel ſhould have two or three tubulated ſtoppers adapted to it. The veſſels and their ſtoppers to be marked with ſimilar numbers.

8. The ſize and number of the purifying caſks muſt be proportioned to the rate of the ſhip, and the convenience with which they can be managed.

9. If the caſk be left with the air veſſel in it during the night, or for any conſiderable length of time, a ſmaller plug may be put into the ſmall hole *(c)* in the top of the caſk, ſo as to leave it not quite air tight.

10. If during the proceſs, the fixed air ſhould eſcape, by the edges of the round bung, it may be prevented by any ſlight luting, which may be eaſily removed when the bung is to be taken out.*

11. It will be ſcarcely neceſſary to mention that the air veſſel and the large circular bung-hole, in the top of the caſk, are to be ſo proportioned, that the latter will eaſily admit of the paſſage of the former through its aperture.

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* The eſcape of air will prolong, but not wholly prevent the ſucceſs of, the proceſs.

The Method of impregnating Water in large Quantities *with Fixed Air, ſo as to give it the Properties of Mineral Water, for the Uſe of the Sick on Board of Ships, and in Hoſpitals.*

DR. PRIESTLEY, ſome years ago, communicated to the Lords of the Admiralty a method of impregnating water with fixed air, obtained from an effervеſcing mixture of chalk and vitriolic acid, and of making an artificial Pyrmont water. This operation has ſince been conſiderably facilitated by the invention of Dr. Nooth's glaſs machine, with Mr. Parker's and Mr. Magellan's improvements.

That machine, though admirably contrived for the preparation of ſuch quantities of artificial mineral water as may be neceſſary in private families, would be too ſmall for the ſickly crew of a large ſhip. But it appears to me that a mode may be adopted by which the proceſs may be performed on a much larger ſcale.

The

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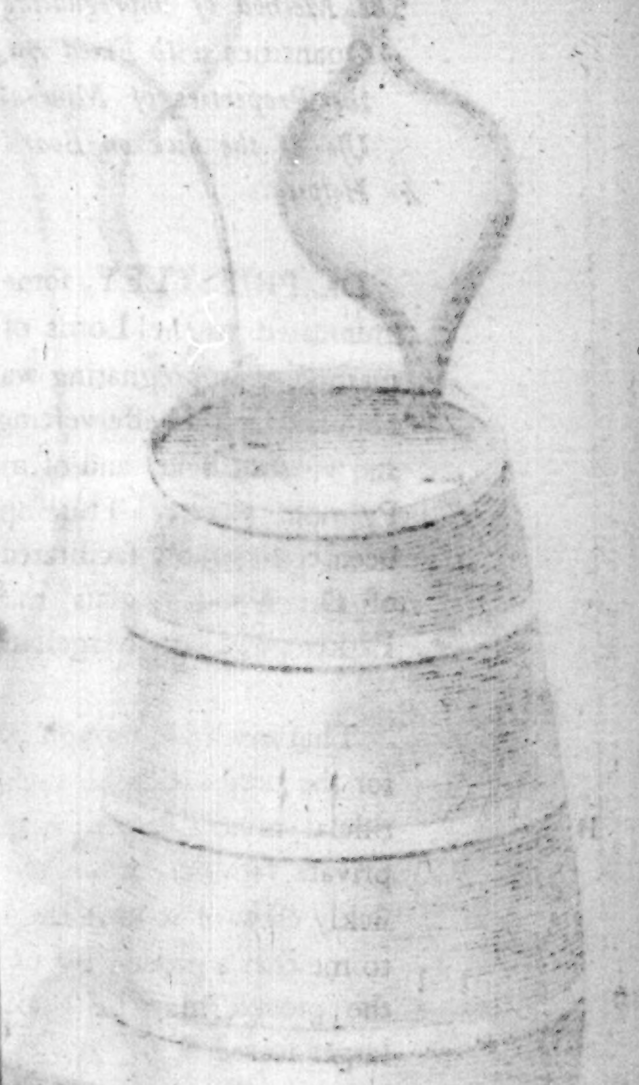

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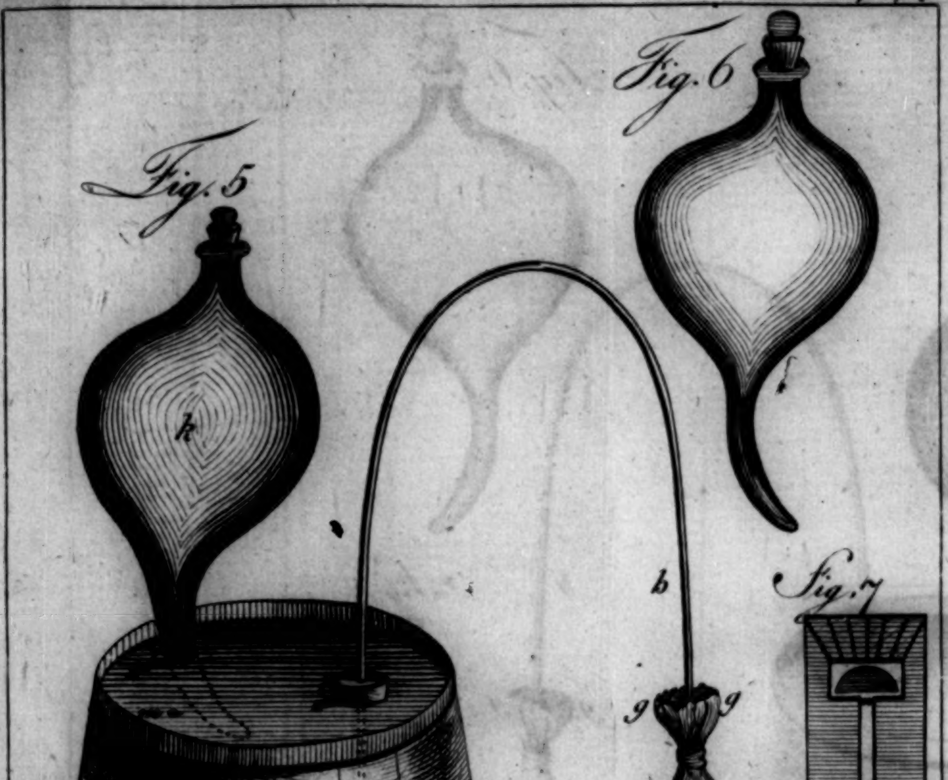

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The advantages which would proceed from an eaſily practicable method of ſupplying the ſick men in long voyages with ſuch water, muſt be obvious to every medical practitioner. The mineral waters of Pyrmont and Seltzer may, by theſe means, be cloſely imitated, and the artificial water will be beneficial in all caſes in which the natural is found uſeful. By this proceſs alſo may Mr. Bewley's mephitic julep be prepared; than which the materia medica, perhaps, does not afford a more efficacious or more grateful medicine in putrid fevers, ſcurvy, dyſentery, bilious vomitings, hectic, &c.

THE PROCESS.

Cut off the two extremities of a calf's or pig's bladder *(f)* (fig. 5.) and having previouſly moiſtened them, into one end inſert the top of the tubular ſtopper *(e)* round the neck of which it is to be cloſely faſtened with ſtrong thread. Into the upper end introduce the part *(g)* of the long bent tube *(b)* and tie them round in the ſame manner. The pipe *(b)* muſt be paſſed through a hole, formed by a hot iron borer, in a large cork adapted to the orifice *(i)* in the caſk (BB) to which it muſt be cemented: and the length of the pipe from this point muſt be ſuch as to reach within a few inches of the bottom of the caſk (BB) which is to be completely filled with freſh water, or ſuch as has been recovered from lime.

To a quantity of mild calcareous earth and water, as directed in the preceding proceſs, placed in the air veſſel (C, fig. 5.) add a ſmall portion of ſtrong vitriolic acid, and by the time moſt of the common air may be ſuppoſed to be expelled by the fixed air, ariſing from the mild calcareous earth, add a larger quantity of acid, and putting the tubulated ſtopper *(e)* in its place, the bladder *(f)* will become inflated. Preſs it gently till its ſides collapſe; and then introducing the pipe *(bb)* with its cork, into the orifice *(i)* of the caſk (BB;) again preſs the air forward, as it diſtends the bladder into the water caſk, where bubbling up through the water, it will riſe to the ſurface, and by its preſſure, force the water to aſcend into the funnel *(k)* which is to be cemented into the head of the caſk at *(l)*. In proportion as the water in the caſk becomes impregnated with fixed air, that in the funnel will return into its place; but if, at any time, the latter ſhould riſe ſo high as to be in danger of overflowing, a quantity of air may be let out of the water caſk, by means of the ſmall plug at *(m.)* And this is neceſſary to be done, ocaſionally, to diſcharge the reſiduum of the fixed air, which is not ſoluble in water.

The water may be taſted from time to time, by drawing off a ſmall quantity at a cock fixed into the caſk, and when it has obtained a ſufficiently pungent taſte, the proceſs may be finiſhed. This will take ſeveral hours, but in this caſe little attendance will be requiſite.* If the operation be required to be performed more expeditiouſly, it may be quickened by agitating the water caſk. To do this, the tubular ſtopper *(e)* muſt be with-drawn from the air veſſel, and ſupported, together with the bladder, by an aſſiſtant, while the caſk (BB) is ſhaken. During this time another tubular ſtopper muſt be put into the air veſſel, and it may be immerſed into a quantity of lime-water to prevent waſte. When the agitation has been continued for ſome minutes, in proportion to the falling of the water in the funnel, replace the ſtopper attached to the bladder *(f)* in the air veſſel when taken out of the lime-water, and proceed as before, repeating the agitation occaſionally.

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* The operator muſt be attentive that the top of the caſk be air tight. If ſome water be poured upon it, any defects may be detected by the air bubbling through the water, and the faulty place muſt be ſecured with luting.

During the proceſs, additional quantities of vitriolic acid may be introduced into the air veſſel through the opening at *(d)* which is to be, at all other times, carefully ſecured with its ſtopper.

Perhaps the moſt convenient ſize for the caſk, intended for the purpoſe of impregnating water with fixed air, would be about ten or twelve gallons. Should the ſcurvy, or other putrid diſeaſes, prevail; or ſhould putrid proviſions or other ſeptic cauſes render the crews more than uſually liable to ſuch diſeaſes, and occaſion a larger conſumption of this water to be neceſſary, the caſk may be proportionably larger, or a greater number of ſmall caſks may be employed.

I FLATTER myſelf that I have now pointed out methods, not only of ſupplying he crews of his Majeſty's ſhips and others, in very climate, with freſh water; but alſo of affording them a medicinal water, which will not only be a preventative againſt putrid diſeaſes, but even a powerful remedy when they ctually exiſt.

The expence of precipitating the lime from he water will be very trifling. I imagine hat, in performing the proceſs in a large way, eight ounces of mild calcareous earth, and ſix ounces of ſtrong vitriolic acid will be ſufficient for ſixty gallons of lime-water. The alue of the firſt is beneath notice, and the preſent average price of oil of vitriol, at a ime that ſulphur is very dear, is only fivepence per pound. It is alſo to be conſidered, hat the whole ſtock of water will not need to have lime added to it; that part only which is deſigned for long keeping will require this treatment.

I would recommend that theſe operations be performed under the inſpection of the ſurgeons of ſhips and their mates; they may be conducted with facility; a little practice will make thoſe gentlemen perfect maſters of the proceſſes; and, I am perſuaded, the liberal ſpirit which prevails among the profeſſors of the medical art, will not only prevent the rejection of an improvement, merely becauſe it is an innovation, but will incite them to reconcile difficulties, if it be poſſible they can occur, to promote the practice of what promiſes ſo much utility, comfort and ſalubrity to a body of men, on whom the enjoyment of our liberty, our property, and our religion ſo eminently depend.

The malt decoction has been found, by experience, to anſwer in a great degree the beneficial intentions of the late truly amiable, humane and ingenious Dr. Macbride, who firſt propoſed the trial of it. And this ſalutary beverage may have its efficacy ſtill farther improved, by impregnating it, in the above manner, with fixed air. Nay, I even believe that the decoction ſo impregnated, and incloſed in veſſels for a few days, would ferment, and furniſh an uſeful and not unpleaſant kind of beer.

I have repeatedly prepared an artificial yeaſt, by impregnating flour and water with fixed air, with which I have made very good bread, without the aſſiſtance of any other ferment. As I apprehend it to be a deſideratum to procure freſh fermented bread at ſea, at leaſt that it would be an agreeable acquiſition to the officers, the proceſs, by which bread has been thus made, ſhall be ſubjoined. And if the above application of chemical facts, which were already known; if an improvement and extenſion of modes which have been already practiſed, on a leſs enlarged plan, may, in any degree, tend to the preſervation of the health and lives of a part of mankind, more particularly expoſed to diſeaſe, I ſhall reflect with pleaſure, while my capacity for reflection remains, that I have not lived unprofitably, but have contributed my mite to promote the eſſential intereſts of my country, and of humanity.

The Proceſs for making artificial Yeaſt.

BOIL flour and water together to the conſiſtence of treacle. When the mixture is become cold, fill a ſmall caſk with it. This caſk is to be fitted up in the ſame manner as that deſcribed (BB, fig. 5.) for the impregnation of water with fixed air, and the proceſs is to be conducted in a ſimilar way, except that the caſk is to be agitated, as often as the mixture riſes to about two thirds of the capacity of the funnel *(k)*; and after each agitation, which ſhould continue during ſeveral minutes, the unabſorbed air is to be let out, by withdrawing the plug from the orifice *(m)* till that part of the mixture which remained in the funnel have returned into the caſk. The orifice at *(i)* ſhould alſo be larger than is neceſſary in the former operation, on account of the ſuperior viſcidity of the mixture. When, on the agitation being frequently ly repeated, the mixture, which has aſcended into the funnel, does not ſubſide into the caſk, it may be ſuppoſed to be incapable of abſorbing more air.

Pour the mixture, thus ſaturated, into one, or more, large bottle or narrow-mouthed jar. Cover it over looſely with paper, and upon that a ſlate or board, with a weight to keep it ſteady. Place the veſſel in a ſituation where the thermometer will ſtand from 70 to 80 deg. and ſtir up the mixture two or three times in twenty-four hours. In about two days, ſuch a degree of fermentation will have taken place, as to give the mixture the appearance of yeaſt.

With this yeaſt, when it appears to be in the above deſcribed ſtate, and before it have acquired a thoroughly vinous ſmell, mix the quantity of flour you intend to make into bread, in the proportion of ſix pounds of flour to a quart of the yeaſt, and a ſufficient portion of warm water. Knead them well together in a proper veſſel, and covering it with a cloth, let the dough ſtand for twelve hours, or till it appear to be ſufficiently fermented, in a degree of warmth equal to that abovementioned. It is then to be formed into loaves, and baked.

Perhaps the yeaſt would be more perfect, if a decoction of malt were uſed inſtead of ſimple water; but of this I have, as yet, had no experience.

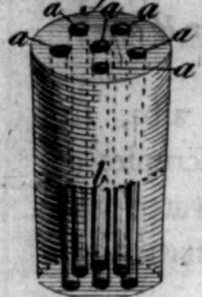
The caſk in which the yeaſt has been made, ſhould be well waſhed as ſoon as the operation is finiſhed, or it will contract a diſagreeable taint.

The Proceſs for making artificial Pyrmont Water.

TO every gallon of ſpring water add one ſcruple of magneſia alba, thirty grains of Epſom ſalt, ten grains of common ſalt, and a few pieces of iron wire, or iron filings. The operation is then to proceed as in the proceſs for impregnating water with fixed air; and the water, if intended for keeping, muſt be put into bottles cloſely corked and ſealed.

The

Fig. 11



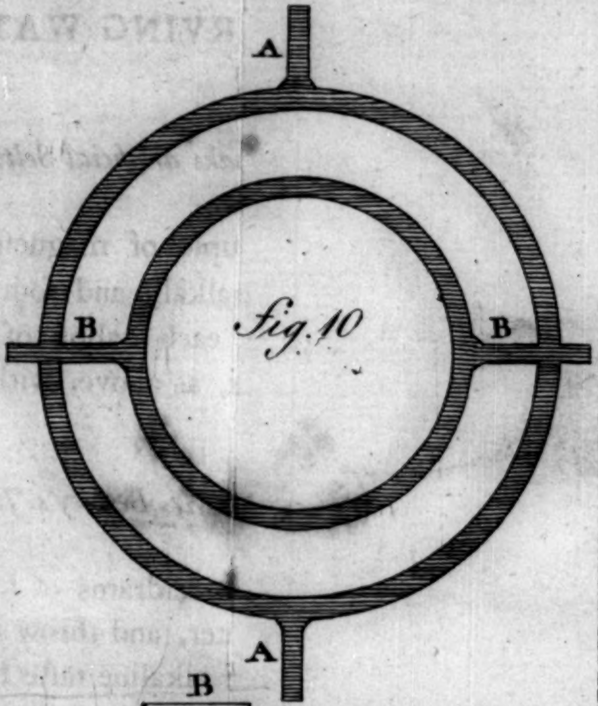


Fig. 10

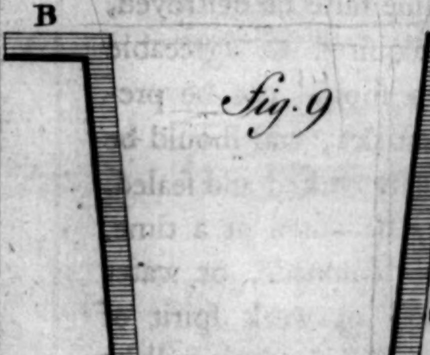
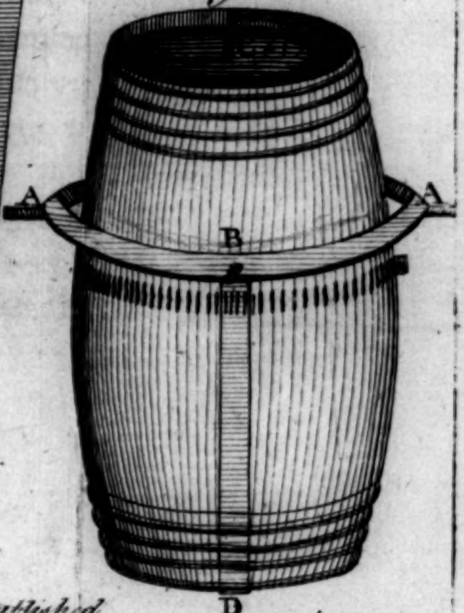


Fig. 9

Fig. 8



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The Proceſs to make artificial Seltzer Water.

ADD one ſcruple of magneſia alba, ſix ſcruples of foſſil alkali, and four ſcruples of common ſalt to each gallon of water, and ſaturate the water, as above, with fixed air.

To prepare Mr. Bewley's Julep.

DISSOLVE three drams of foſſil alkali in each quart of water, and throw in ſtreams of fixed air, till the alkaline taſte be deſtroyed, and the water have acquired an agreeable pungency. This Julep ſhould not be prepared in too large quantities; and ſhould be kept in bottles very cloſely corked and ſealed. Four ounces of it may be taken at a time, drinking a draught of lemonade, or water acidulated with vinegar, or weak ſpirit of vitriol, by which means the fixed air will be extricated in the ſtomach.

REFERENCES TO THE PLATES.

FIG. 1. AA is the caſk in which the lime-water is to be purified. It is repreſented as tranſparent for the purpoſe of ſhewing the ſituation of the whole apparatus.

(a) Is the moveable top.

(b) The handle.

(c) A ſmall hole to be exactly fitted with a plug.

(dd) The ſtrings by which the air veſſel is to be let down.

(ee) Two pegs, placed on oppoſite ſides of the caſk, to which the ſtrings are to be faſtened before the caſk be ſtopped.

(f) A cock to draw off the water.

Fig. 2. DD. The air veſſel, ſimilar to the bottom part of Dr. Nooth's glaſs machine.

(cc) A glaſs ſtopper, ground in to fit the mouth of the veſſel, having a number of capillary tubes running from bottom to top in a diverging direction, ſo as to ſpread the

air in its paſſage through the water. Perhaps this veſſel might be made of pewter inſtead of glaſs, but in that caſe, as the tubes will be larger, a valve would be neceſſary in the ſtopper. I apprehend, likewiſe, that it may be formed of ſtone-ware; but whatever be the materials, the veſſel ſhould be ſtrong, and ſo heavy as to ſink readily in water, by its own weight.

Fig. 3. The ſtopper viewed ſeparately to ſhew its capillary tubes.

Fig. 4. A lead weight with an aperture in the middle, to ſlip over the ring of the handle *(b)* fig. 1.

Fig. 5. BB. A caſk whoſe ſides and ends muſt be perfectly air tight, except two holes to be bored in the top.

C. The air veſſel, the ſame as fig. 2. but having an aperture at *(d)* which is to be fitted with a glaſs ſtopper, through which additional quantities of vitriolic acid may be introduced.

(e) The perforated ſtopper, which muſt have ſeveral circular or ſpiral grooves round its

upper part, to facilitate the faſtening of the bladder *(f)* to it, the other end of which muſt be attached in a ſimilar manner to the broad end of the pipe *(h)* at *(gg.)*

(h) A long bent pipe made of pewter, having its lower extremity formed like the larger end of a cliſter pipe. The length from the arch to the other extremity muſt be ſuch as to reach, nearly, to the bottom of the caſk BB. This pipe muſt be cemented into a cork to fit the orifice in the caſk at *(i.)*

(k) The funnel, with a grooved cork or ſtopper adapted to it, which is to be inſerted and luted into the top of the caſk at *(l.)*

(m) The ſmall hole, with a plug, to let out the portion of air, from time to time, which is incapable of being abſorbed by the water.

Fig. 6. A ſeparate view of the funnel, which may be fabricated of tin, or copper covered with tin.

Fig. 7. Is a longitudinal ſection of an earthen ſtopper, with a valve and capillary tubes communicating with a larger tube ariſing from its bottom. I am informed by the glaſs-makers, that *diverging* capillary tubes are not eaſily formed in large bodies of glaſs; and I am induced to think that their diverging is not of ſo much importance as I at firſt apprehended.

The following figures are deſcriptive of the mode of ſuſpending the caſk, which will be taken notice of in page 37.

Fig. 8. Is an elevation of the caſk, with its gimbols AA—and B, gimbol of the bearing hoop. C the bung—D the bearing hoop paſſing under the caſk.

Fig. 9. The bearing hoop and gimbols BB.

Fig. 10. A plan of the bearing hoop and outer hoop, with the gimbols $\left\{\begin{matrix}\text{BB}\\ \text{and}\\ \text{AA.}\end{matrix}\right\}$

The ſcale is an inch to the foot, ſuppoſing the caſk made uſe of to be a puncheon.

N. B. The gimbols AA, muſt be inſerted into two ſtanchions under any of the hatchways of the ſhip, and the inſertion muſt be ſo high, as to prevent the bottom of the caſk from touching the deck below, by the motion of the ſhip, and theſe ſtanchions muſt ſtand tranſverſely or athwart ſhips.

Fig. 11. Is a pewter ſtopper with compartments *a a a a a a*, into which ſmaller glaſs ſtoppers containing capillary tubes are to be filled, and theſe are to communicate at *b*, with paſſages proceeding from the lower ſurface of the ſtopper.

POSTSCRIPT.

An unavoidable delay, in the publication of the preceding ſheets, has afforded me an opportunity of ſubmitting them to the peruſal of ſeveral gentlemen diſtinguiſhed for their philoſophical knowledge, and to others who to ſcience have had opportunities of adding long experience in maritime affairs. I am happy in having received from many a full, and from all a general approbation of my ſcheme; and hope it is now in my power to remove the few objections which have been made to it.

My particular acknowledgments are due to Dr. Lind of Haſlar hoſpital, who was ſo kind to give the pamphlet a candid and attentive peruſal. In a letter with which he has been pleaſed to favour me, he declares his opinion that the method I have propoſed for preſerving water, at ſea, from putrefaction, *well deſerves a public trial.* "I make no doubt," ſays this ingenious phyſician, "but very conſiderable advantages would be derived from it in ſome ſituations, but am afraid in others, the agitation of the ſhip would obſtruct the proceſs." This is the only objection which Dr. Lind makes *from himſelf*; he then proceeds to ſtate ſuch as may perhaps be made by *others*. "With ſome people alſo," he obſerves, "who are accuſtomed to object to every innovation that is attended with any trouble, and whoſe principles they do not comprehend, difficulties may be ſtarted about the prudence of impregnating all the water with lime, and depending on a proceſs to render it fit for uſe, which tempeſtuous weather, the brittle materials of the veſſels employed, and even, ſometimes, the neceſſary duties of the ſhip might interrupt for a length of time. Their prejudices would even urge the time required for purefying the water, and the room taken up by an additional caſk or two, had for that purpoſe upon deck, as objections which, at leaſt, it would require time to remove. I take the liberty to point out the greateſt objections that occur to me as being *capable* of being made againſt its uſe, that you may have an opportunity of ſatisfying *others* with reſpect to them, for with reſpect to *myſelf*, I think that all theſe inconveniences would be more than counter-balanced by having good water at ſea, which muſt materially contribute to the health of the people who drink it."

I with pleaſure embrace the opportunity which Dr. Lind has ſo kindly given me, of ſatisfying thoſe in whoſe minds theſe doubts may have ariſen, on peruſing the propoſed method. On mentioning the Doctor's apprehenſions that the proceſs might not be always practicable, in a rough ſea, to captain William Roberton, formerly of the marines, a gentleman of great experience, and eminent for his ſkill in mechanics; actuated by principles of humanity and zeal for the ſervice, he has, very obligingly, furniſhed me with a mode of ſuſpending the purefying caſk in ſuch a manner, that it may always retain its level, whatever be the motion of the ſhip. A plan, &c.

of the apparatus to be uſed for this purpoſe, from a drawing with which captain Roberton has favoured me, will be found in the third plate, to which, and the annexed deſcription, I beg leave to refer the reader for farther information.

By this means the proceſs may be carried on in all weather; but it is not neceſſary it ſhould be performed only *immediately when the water is wanted:* The operation may be continually going on, it will require very little attendance, and the water when freed from the lime will keep a conſiderable time; much longer, I expect, for reaſons, which will ſoon be adduced, than freſh water from the ſpring.

Veſſels made of ſtone-ware, of ſuch ſtrength as to make them heavy enough to ſink in water, would not be very liable to be broken. If the cautions I have given be properly obſerved, there will be no danger of exploſion, even if the whole quantity of acid be *gradually* added at one time. It would be ingratitude in me to omit profeſſing my obligations to my very worthy and ingenious friend Mr. Wedgwood, for his great and diſintereſted attention in preparing models of the air veſſels, though he candidly acknowledges the veſſels may be more advantageouſly made of what is commonly called ſtone-ware. But ſhould theſe be found ſubject to the inconvenience alluded to, every end will be anſwered by the uſe of pewter veſſels.* The principal difficulty with reſpect to the employing of pewter in the fabrication of the air veſſels was the ſuppoſed impracticability of forming capillary tubes in ſtoppers of that metal. Fig. 11. exhibits a view of one, in which are ſeveral compartments to be fitted with ſmaller glaſs ſtoppers containing capillary tubes; theſe communicating with other tubes proceeding from the lower ſurface of the ſtopper.

A very ingenious correſpondent has ſuggeſted that inconvenience might ariſe, from the precipitating lime falling on the ſtoppers and blocking up the capillary tubes. But it is to be conſidered, that the conſtant emiſſion of air through theſe tubes muſt prevent this impediment. In all the experiments I have made, ſuch an event has never happened; but ſhould it ever appear that this apprehenſion is well grounded, a piece of bladder perforated, in ſeveral places, with a fine pin or needle, or a double piece of fine linen cloth, tied tightly round the neck of the veſſel, allowing the upper part to diſtend into a convex form, will entirely preſerve the tubes from being obſtructed. Indeed, from ſeveral experiments I have lately made, either of theſe coverings, when tyed over a perforated cork, or pewter ſtopper, or even over the mouth of the air veſſel without either cork or ſtopper, will ſerve as a ſubſtitute for capillary tubes: and thus the danger of the proceſs being impeded by accidents to the apparatus is almoſt annihilated; for any large bottle, weighted ſo as to ſink in water, which may be done by a ſufficient quantity of pebbles, and tyed over in the above method, may be employed as an air veſſel for the precipitation of the lime.

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* The beſt London pewter contains but a very ſmall portion of lead, and conſiſts chiefly of tin or biſmuth; and as the affinity of vitriolic acid to calcareous earth, ſo far exceeds its affinity to lead; there can be no danger of any ſaturnine impregnation to the water.

I have never been at ſea; but ſo little attendance does the proceſs require that I cannot conceive it will ever interfere with the neceſſary duties of the ſhip. In the diſtillation of ſea water the conſtant attendance of at leaſt two men is required.—In the operation of precipitating the lime from the water, when the air veſſel is immerſed, the proceſs goes on of itſelf and during the whole time will ſcarcely require fifteen minutes attendance. Theſe obſervations will alſo obviate the objection reſpecting the length of time required for the operation. I believe I have in the preceding account extended it to the utmoſt; but in a proceſs which is almoſt, ſelf-conducted, and continually going on, this objection can have no weight. As to the room taken up by the additional caſks, captain Roberton aſſures me they may be conveniently diſpoſed of under the hatchways and removed occaſionally without any impediment to the buſineſs of the ſhip. But if the advantage of being ſupplied with ſweet inſtead of putrid water, be not ſuperior to every trifling inconvenience that may be urged, it is not worthy the reſearch.

I truſt I have now anſwered every objection that can be made againſt my propoſals. One circumſtance has appeared ſince the printing of the former part of this account, which was entirely unexpected, but muſt prove an additional recommendation of the method. Water is not only preſerved from putrefaction, but meliorated from its original qualities by the operation, which has much the ſame effect, in ſome inſtances, as diſtillation upon it; with this advantage, that the water is not deprived of its air by the proceſs, as it is when diſtilled. Very hard water, from different pumps, having been impregnated with quick-lime, and afterwards freed from it by means of fixed air, was rendered ſoft as rain-water, afforded little or no precipitation when a ſolution of fixed alkali was added to it, and united readily and perfectly with ſoap: whereas, previous to the operation, it depoſited a very large ſediment on the addition of fixed alkali, and formed turpeth mineral on dropping in a ſmall quantity of a ſolution of quick-ſilver in nitrous acid. But, notwithſtanding theſe proofs that the water contained a vitriolic ſalt, it muſt remain to be determined, by farther experiments, whether the water, uſed in theſe trials, owed its hardneſs, *principally*, to ſuch a ſalt, or, like the Rathbone-place water, to calcareous earth diſſolved in it by means of fixed air. Lime-water mixed with it, in equal proportions, became turbid, and, when the precipitate had ſubſided, the water was ſoftened.

THE END.

B L

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